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PART A

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Estimation of Capacity of Lead Acid Battery Using RBF Model

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Abstract – *Analytical models have been developed to diminish test procedures for product realization, but they have only been partially successful in consistently predicting the performance of battery systems. The complex set of interacting physical and chemical processes within battery systems have made the development of analytical models to be a significant challenge. Advanced simulation tools are needed to become more accurately model battery systems which will reduce the time and cost required for product realization. As an alternative approach, we have begun development of cell performance modeling using non-phenomenological models for battery systems based on Radial Basis Function which uses Matlab 7.6.0(R2008b). A Radial Basis Function based learning system method has been proposed for estimation of capacity of lead acid battery. Radial basis function based technique is used for learning battery performance variation with time, temperature and load. Thus a precision model of Radial Basis Function has been evaluated. The correlation coefficient of this model is worth 0.99977 shows good results for the target and network output.*

Keywords: *Neural Network, Radial Basis Function, Electrochemistry, Lead Acid Battery, Capacity*

Nomenclature

n	Amount of data for RBF model
e	Natural logarithm
x	Variable data function
R^d	Data position
r	Distance of data
S	Linear combination of function RBF
ϕ	Function of RBF
λ	Coefficient of RBF
A	Matrix of RBF
E	Function of RBF model
p	Number of input
w	Weight of RBF model
b	Bias of RBF model
D_{ij}	The distance data-i with data-j
a	Network output
Q	Capacity of battery
ΔQ	Error of capacity estimation
i	Current of battery
T	Temperature of battery

Abbreviations

RBF	Radial Basis Function
SOC	State of Charge

I. Introduction

The need to develop electric vehicles arises not only due to the high price of international petroleum but also for solving the worsening environment problems.

Energy management is the major key technology of battery powered vehicle [1]. The increase of energy density and efficiency, and accurate measurement of the capacity are important research topics [2], [3]. Although many new electrochemical systems were studied for this application, the lead acid battery is still a leading candidate [4]. Measurement of the capacity of lead acid battery in battery powered vehicle was studied by electrochemical reaction [5]. The estimation of capacity of lead acid battery is a key point of energy management system in electric vehicle [6].

Many methods are used to improve the precision of battery capacity. Generally, the methods for measuring the capacity of the lead acid battery are: impedance method, conductance method or resistance method [7], [8].

The parametric fitting model method may not be accurate enough for the measurement of the capacity of the lead acid battery in the electric vehicle because the internal resistance of the battery is not constant [9]. These methods are only used for the batteries of the same model to be evaluated. This approach does not work anymore if the battery has some differences. The Coulometric method can measure the charge or discharge current of battery to solve the above disadvantages [10]. The Coulometric measurement method usually uses several correction factors added to minimize the errors and used together to determine the capacity.

The Ampere hours algorithm commonly estimate the battery capacity. The battery capacity is calculated by multiplying the current by time of discharge [11], [12].

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